Excerpted from the SFAN Draft Vital Signs Monitoring Plan – December 2004:

Table 5.1 Key Information from Protocol Development Summaries for each of the top 18 indicators.

Indicator Name (rank)	Justification	Monitoring Objectives	Parks Involved
Weather and Climate (1)	Key reasons for monitoring weather and climate in network parks are: (1) weather/climate is the primary driver of the short and long-term distribution and abundance of plant and animal populations, (2) weather/climate has effects on air and water quality, and (3) weather/climate has effects on drought and flood cycles, fires, mass wasting and other catastrophic events. Long-term weather data can contribute to the understanding of global climate change and its effects on Network ecosystems	To provide support data for other vital signs indicators in order to help understand trends in aquatic species populations, plant populations and habitat, wildlife, pollution transport, erosion/deposition, and other natural processes and features. Develop rating curves for a range of environmental conditions, land use, and weather patterns for each water body (e.g., compare a drought year vs. an El Niño year) in order to gain an overall understanding of hydrologic systems within the SFAN. Collect data that can be integrated with data collected by other local and regional entities.	EUON, GOGA, JOMU, PINN, PORE
Invasive Plant Species (2)	We have selected early detection of invasive terrestrial and aquatic plant species for its proven effectiveness in preventing the establishment of new species, the spread of existing species and invasion into uninfested areas. It is also relatively easy to implement an early detection monitoring program at several locations targeting a multitude of species with different levels of intensity. This indicator provides information that can be used immediately by managers in the field as well as provide data on long-term infestation patterns and assist with managing for the prevention of invasions.	Detect new species and new populations within parklands in order to guide removal and management. Determine the trends in vector pathways and susceptible ecosystems within SFAN parks. Maintain uninfested areas in sensitive habitat.	FOPO, GOGA, JOMU, MUWO,PINN, PORE, PRES
Freshwater Quality (3)	The SFAN has many unique aquatic resources that are significant in an ecological and economic context. Freshwater systems within the network support a variety of threatened and endangered species. Freshwater quality	Maintain waters that vary within their natural chemical and biological ranges and meet applicable federal and state water quality criteria.	GOGA, JOMU, PINN, PORE

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	has direct impact on several other indicators including: marine water quality, stream T&E species and fish assemblages, T&E amphibian and reptiles, riparian habitat, wetlands, and aquatic macroinvertebrates. Freshwater quality also indirectly impacts plant and animal life.	Improve water quality of impaired waters. Maintain high water quality where it exists.	
Air Quality (4)	Air quality is linked to many natural processes, i.e. soil and water nutrients, photosynthesis, acidification of lakes and streams. PINN and PORE are rated as Class 1 areas by the Clean Air Act and are protected by strict air quality regulations. The rest of the parks in the SFAN are Class 2 areas and pollution regulations are less strict. However, in some instances federal land managers apply the "precautionary principle" and treat Class 2 areas with the same standards as Class 1 Areas. Within NPS, a majority of parks show improvements in visibility on clear days and in the concentration of sulfates present in precipitation. Nearly all parks show degradation or no change in nitrate levels in precipitation. Almost half of the parks show significant degradation in ozone levels, with only few showing an improvement. Hazy conditions persist in most parks.	Identify air pollutants which may injure or damage park natural resources, measure these pollutants and correlate observed effected on resources to ambient levels of pollution. Establish baseline visibility conditions, deposition, and air pollutant concentrations. Identify and assess trends in air quality. Determine compliance with National Ambient Air Quality Standards. Provide data for the development and revision of national and regional air pollution control policies that are protective of park resources. Provide data for atmospheric model development and evaluation. Determine the relative importance of various atmospheric constituents to visibility impairment. Determine the sensitivity of individual areas or views to variations in visual air quality.	GOGA, PINN, PORE
Stream Fish Assemblages (5)	The Stream Fish Assemblage indicator includes monitoring for three threatened and endangered aquatic species. Coho salmon and steelhead are anadromous and the life stage requirements demand year-round, high-quality cold water, continuous riparian cover, and complex habitat and structure to accommodate	Describe salmonid habitat condition, distribution, status and trends within NPS watersheds supporting salmonids. Measure the range and relative abundance of CA freshwater shrimp within NPS watersheds supporting	GOGA, JOMU, PINN, PORE

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	development from egg to smolt stage. Monitoring of these species at multiple life stages is valuable to the understanding of aquatic conditions and health of the watershed. Because the salmonids live for more than a year in freshwater, and the conditions required to support them are highly restrictive, they are susceptible to anthropogenic impacts to the stream and riparian systems, and are therefore effective indicators of stream and aquatic health. California freshwater shrimp are highly sensitive to water quality and changes to habitat.	these species. Assess fisheries condition and watershed health through summer monitoring throughout SFAN.	
Rare & T/E Plants (6)	PORE has over 50 plant species with federal, state or local status. GOGA has over 35 plant species, including those at PRES, with federal, state or local status. The inventory for PINN needs to be refined and better documented, but there is currently evidence for over 10 sensitive species. In the summer of 2004, a ranking system was developed to help the parks determine which species are the "most rare" within the park boundaries regardless of official listing status. A different version of the ranking matrix will be used to determine which species are the most appropriate for long-term monitoring for trends and ecosystem health. We are developing a systems approach to monitoring rare plants, while also addressing management needs. This indicator is also part of a hierarchy of vegetation monitoring being developed by the working group, in which some rare species will be monitored via the plant community change protocols.	Detect trends in rare plant populations at SFAN parks. Utilize rare plant data as part of a hierarchical vegetation monitoring program by incorporating appropriate species into plant community change monitoring and conducting species specific monitoring of populations that rank high in the monitoring prioritization matrix. Use rare plant data with relevant wildlife and other indicator monitoring, such as T&E butterflies and wetlands, for assisting with trend detection and causal relationships.	GOGA, PORE, PRES, PINN
Northern Spotted Owl (7)	The federally threatened status of this species requires the NPS monitor the long-term status and trend of the population and maintain stable or increasing populations of spotted owls. This monitoring program provides the data required to accurately assess the status and trend of this isolated, potentially vulnerable spotted owl population, where it occupies a land use matrix strikingly different from that found throughout most of the owl's range. Our monitoring program contributes to the Northwest Forest Plan in working to arrest the downward	Determine spotted owl reproductive status and success by site, and age and sex classes within the study area Estimate the rate of population change over time. Measure nest-site and nesting habitat characteristics. Document occurrence of West Nile Virus in the spotted owl population.	MUWO, PORE

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	trend in spotted owl populations and in maintaining and restoring the habitat conditions necessary to support viable populations of the northern spotted owl on federally administered forest lands throughout the range of the owl. The program has an eight-year history of monitoring spotted owls in the SFAN parks, which contributes to region and range-wide monitoring programs and park management activities. Owls are also good indicators of forest ecosystem condition because they area associated with multi-tiered, old growth forests.	Document the occurrence of Sudden Oak Death within spotted owl habitat. Monitor distribution and abundance of barred owls in Marin County and document any occurrences of hybridization. Utilize monitoring program to guide management and promote species recovery. Determine whether wildland urban interface fire management actions affect spotted owl distribution and productivity.	
Amphibians and Reptiles (8)	The protected legal status of these taxa require the NPS to evaluate the condition of these populations. Due to their habitat and physiology, these taxa are particularly sensitive to environmental degradation, such as air and water pollution. Because they are mid-level predators, population trends in these taxa may indicate trends in populations of animals at both higher and lower trophic levels. Standard protocols are available for sampling these animals in the San Francisco Bay Area, in some cases long-term data sets already exist. In addition to monitoring the two federally protected herptile species found in the network, the protocol will also address monitoring of terrestrial amphibian and reptile assemblages. The number of species and populations of amphibians are declining worldwide.	To detect trends in amphibian and reptile assemblages. To determine population status of key threatened and endangered amphibians and reptiles, such as California red-legged frogs and the San Francisco garter snake. To determine the natural variability in amphibian and reptile assemblages.	PORE, GOGA, PINN, JOMU, MUWO, PRES
Western Snowy Plover (9)	Western snowy plovers are listed as federally threatened under the Endangered Species Act. They are also part of the coastal dune ecosystem, which is identified in the PORE enabling legislation. Western snowy plovers are good indicators of the condition of the coastal dunes ecosystem and are the only nesting shorebird in the coastal strand. There is a long history of monitoring snowy plovers at PORE and GOGA. in collaboration with other organizations and agencies. Several park management actions, including major dune habitat	Monitor breeding population size, distribution, reproductive success, and population ecology of western snowy plovers. Monitor patterns of non-breeding seasonal and spatial distribution of snowy plovers. Study predator activity and mortality events on snowy plover eggs and chicks, adults.	GOGA, PORE

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	restoration projects, at PORE and GOGA are monitoring success of the projects based on the recovery of snowy plovers.	Opportunistically analyze pollutant loads in plover eggs, chicks or adults.	
Pinnipeds (10)	Pinnipeds come under the legal mandates of the Endangered Species Act and Marine Mammal Protection Act. They are also specifically identified in the enabling legislation of and management objectives of PORE. Pinnipeds are good indicators of the condition of the marine ecosystem and global climate change because they respond quickly to oceanic conditions and food resources, such as El Nino events. There is a long history of monitoring pinnipeds at PORE and GOGA in collaboration with other agencies and organizations.	Determine population size, distribution, reproductive success, and population ecology of pinniped populations that depend on resources within the SFAN parks, and thereby, the condition of the marine ecosystem. Provide an early warning of abnormal conditions and impairment of the marine ecosystem and of pinniped populations. Provide better data to understand the dynamic nature of the marine ecosystem.	GOGA, PORE
Plant Community Change (11)	Numerous biotic and abiotic factors have altered and continue to threaten plant communities within SFAN. As plant communities continue to recover from past resource extraction and grazing, there is a need to understand how current activities are effecting this recovery. It is also important to monitor and evaluate changes to the composition of plant communities and type changes occurring on the landscape. The monitoring program proposed assimilates significant elements of invasive plant species (2nd), threatened and endangered plant species (4th), wetlands (15th), grassland plant communities (31st), oak woodlands (37th), and plant species at the edge of their range (58th) for a significant sub-set of the species within these other broad indicator categories. There are also significant ties between plant community change and almost all of the faunal indicators being monitored such as landbirds, Northern spotted owls, endangered butterflies, etc.	Measure changes in a variety of key plant communities in SFAN parks. Determine trends in native and non-native abundance and distribution in SFAN parks. Coordinate data analysis with other indicators including rare plants, wetlands, riparian habitats and early detection of invasive species for more robust trend detection. Complete vegetation monitoring in areas that would benefit wildlife indicator monitoring such as landbirds, spotted owls and butterflies.	FOPO, GOGA, JOMU, MUWO, PINN, PORE, PRES
Landscape and Land	Key reasons for monitoring regional landscape & land use change are (1) the rapid development of neighboring lands (2)the fragmentation of wildlife habitat (3)the need to detect life-form change within parks, and (4) to	Assess the current condition of park landscapes and adjacent land use. Detect large-scale shifts in vegetation patterns throughout SFAN parks (i.e. grassland to shrubland;	EUON, FOPO, JOMU, GOGA, MUWO, PINN, PORE, PRES

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Use Change (12)	provide early warning of large-scale community shifts.	chaparral to forest). Determine location and condition of wildlife corridors throughout the SFAN. Coordinate data analysis with early detection of invasive species to detect infestation corridors and adjacent populations.	
Threatened and Endangered Butterflies (13)	The protected legal status of these taxa require the NPS to evaluate the condition of these populations. Because they are closely tied to host and nectar plants, butterfly populations are good indicators of general health of habitat.	Determine the trends in populations of threatened and endangered butterflies within GOGA and PORE. Determine whether the distribution and quality of habitat is changing and how changes impact butterfly populations.	GOGA, PORE
Freshwater Dynamics (14)	Freshwater dynamics/stream hydrology data provides key "support" data for other vital signs indicators including freshwater quality, groundwater dynamics, stream T&E species and fish assemblages, T&E amphibians and reptiles, erosion & deposition, wetlands, and riparian habitat.	Provide support data for other vital signs indicators in order to help understand trends in aquatic species populations, pollution transport, erosion/deposition, and other natural processes and features. Develop rating curves for a range of environmental conditions, land use, and weather patterns for each water body (e.g., compare a drought year vs. an El Niño year) in order to gain and overall understanding of hydrologic systems within the SFAN.	GOGA, JOMU, PINN, PORE
Wetlands (15)	Wetlands are keystone ecosystems in the San Francisco Bay Area. Some ecologists call wetlands "the kidneys of the landscape" as they provide water quality protection, flood and drought mitigation, erosion control, and groundwater recharge functions. Wetlands support complex food webs, housing a rich biodiversity of wetland-endemic species, and providing habitat functions for many aquatic and terrestrial species. An estimated 46% of US endangered and threatened species and 50% of all bird species require wetland habitat (USFWS). Wetland habitats are vulnerable to alteration due to global climate change and associated potential temperature, hydrology, and salinity regime changes. Understanding the condition of wetlands in SFAN parks may be a good	Detect changes in wetland hydrology in SFAN parks. Determine if the extent, type, condition and function of wetlands is changing. Use this monitoring data in conjunction with plant community plot data for analysis of vegetation in SFAN wetlands (including native species cover, invasive species encroachment, etc.) Use data in conjunction with focal species indicators such as fish and pinnipeds.	GOGA, JOMU, MUWO, PINN, PORE, PRES

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	proxy for understanding the condition of many taxa of concern in the network.		
Riparian Habitat (16)	Riparian habitat is closely tied to the health of both wetlands and streams, two indicators that the network has proposed for monitoring. Riparian habitat also influences stream fish assemblages. Characteristics of riparian habitat structure such as the ratio of edge to interior, the degree of canopy complexity within riparian strata (e.g., herb/forbs, shrubs, sub-canopy tree, and overstory tree), and the degree of fragmentation is highly associated with amount and type wildlife use.	Assess the habitat structure and function of riparian systems throughout SFAN. Detect trends in biotic and abiotic functioning of riparian systems. Relate riparian monitoring data to other indicators such as stream fish assemblages. Coordinate hierarchical data collection strategy with plant community change monitoring for riparian vegetation metrics. Use data in conjunction with focal species indicators such as stream fish assemblages.	GOGA, JOMU, MUWO, PINN, PORE, PRES
Landbirds (17)	Landbirds are good indicators of terrestrial ecosystems and numerous dynamic processes interacting together have the potential to affect their abundance and distribution. Landbird monitoring is focused in riparian and coastal scrub/chaparral habitats. Changes in species abundance and distribution may be caused by changes in habitat, food supply, park management strategies, disturbance to nesting areas by recreational users, or environmental factors on multiple scales (localized storm events to decadal shifts in climate).	Determine the distribution and relative abundance, reproductive success, and population ecology of landbird populations covering an array of species that depend on resources within the SFAN of parks, and thereby, the condition of the terrestrial ecosystems. Provide an early warning of abnormal conditions and impairment of the terrestrial ecosystems and of landbird populations. Provide information on how changes in habitat quality or climate impact landbird populations. Provide a model system to assess the effects of habitat restoration or natural disturbance events. Provide information on rare and sensitive landbird species within the parks.	GOGA, JOMU, PINN, PORE, PRES
	Long-term trends in the nesting success and productivity of prairie falcons provide a means for assessing the park's	Determine annual nesting success at Pinnacles NM as measured by territories occupied, number of chick	PINN

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Raptors and Condors (18)	ability to adequately manage climbing use and the overall ecological integrity and sustainability of the rock/cliff ecosystem. Long-term patterns in population size and breeding behavior (e.g. feeding rates of chicks) are compared to long-term climate change, effects of conversion and development of agricultural lands surrounding the monument, and visitor use of the monument. This information will improve the understanding of raptor ecology and the effects of park management decisions.	produced and number of chicks fledged. Improve our understanding of raptor-human interactions and the effects of management actions such as climbing advisories have on bird populations.	